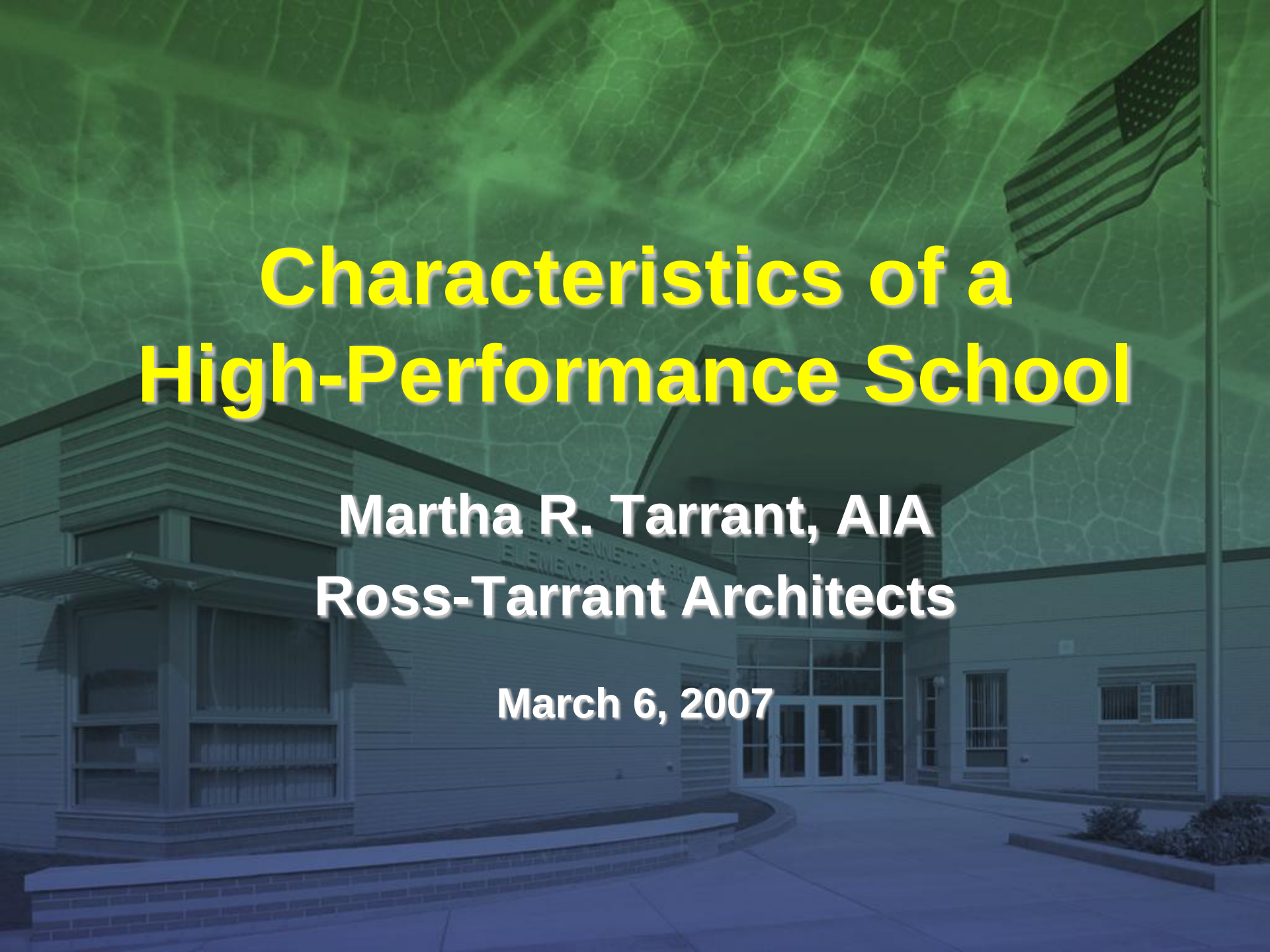


Characteristics of a High-Performance School

Martha R. Tarrant, AIA
Ross-Tarrant Architects

March 6, 2007

High-Performance School Buildings

Four Guidelines

1. Energy Star
2. USGBC LEED™ Certification
3. Kentucky Green & Healthy Schools Program
4. Sustainable Building Industry Council (SBIC) HP Schools

Energy Star Schools

- Energy Star is a joint program of U.S. DOE and U.S. EPA.
- Energy Star is a performance standard; to qualify as an Energy Star school building, a full year of actual energy consumption is used to determine if a building performs in the top 25th percentile of all school buildings in the ES database nationwide.
- 2007 Kentucky legislature bill being considered

Energy Star Schools

- Top-performing Energy Star schools cost 40 cents per square foot less to operate than the average performers.
- Tools to help you determine the target energy consumption levels for ES are on the Web at http://www.energystar.gov

LEED Certification

- Voluntary national standard
- Recognizes achievements
- Promotes integrated, whole-building practices
- Raises awareness of green building benefits
- LEED for schools is being introduced March 2007

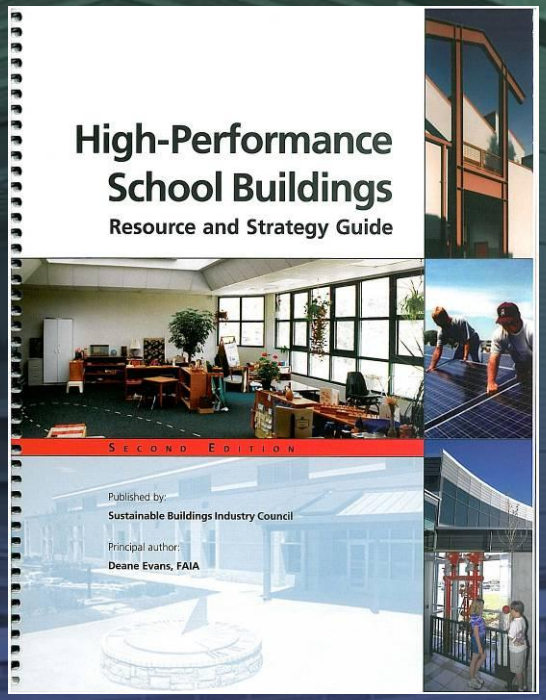
Kentucky Green & Healthy Schools Program

- Promote and recognize efforts for high-performance schools in Kentucky
- Defines standards
- Provides technical assistance

Sustainable Buildings Industry Council (SBIC)

High-Performance School Buildings

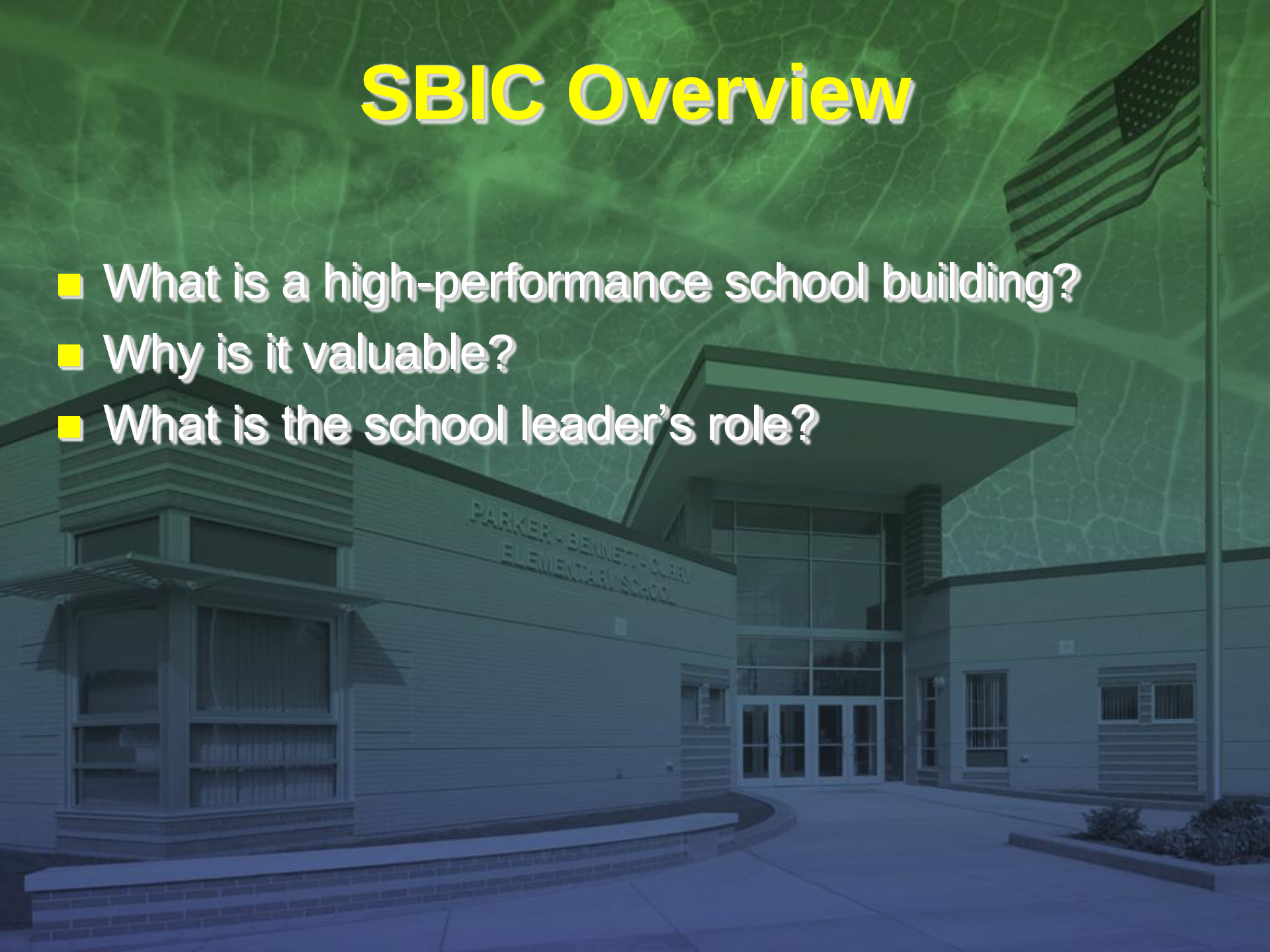
Resource & Strategy Guide



- Seventeen building blocks

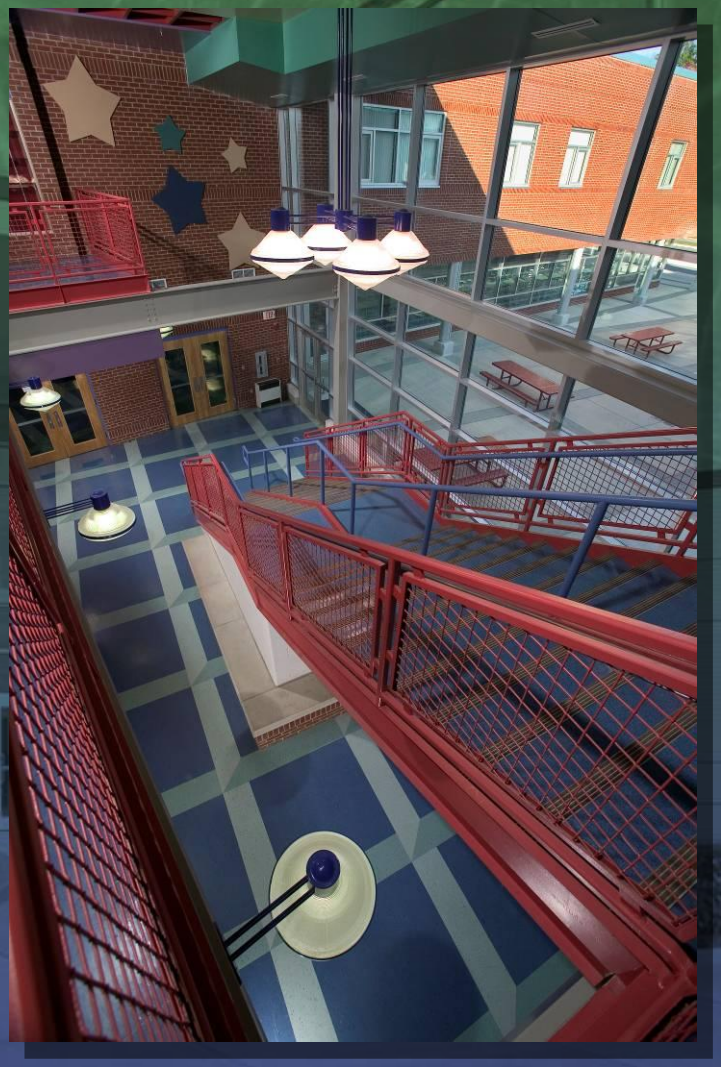
SBIC Overview

- What is a high-performance school building?
- Why is it valuable?
- What is the school leader's role?



What Is a High-Performance School?

- Four characteristics
  - Healthy and productive
  - Cost effective
  - Sustainable
  - Holistically designed



Healthy and Productive

- High levels of acoustic, thermal and visual comfort
- Large amounts of natural daylight
- Superior indoor air quality
- Safe and secure environment

Cost Effective

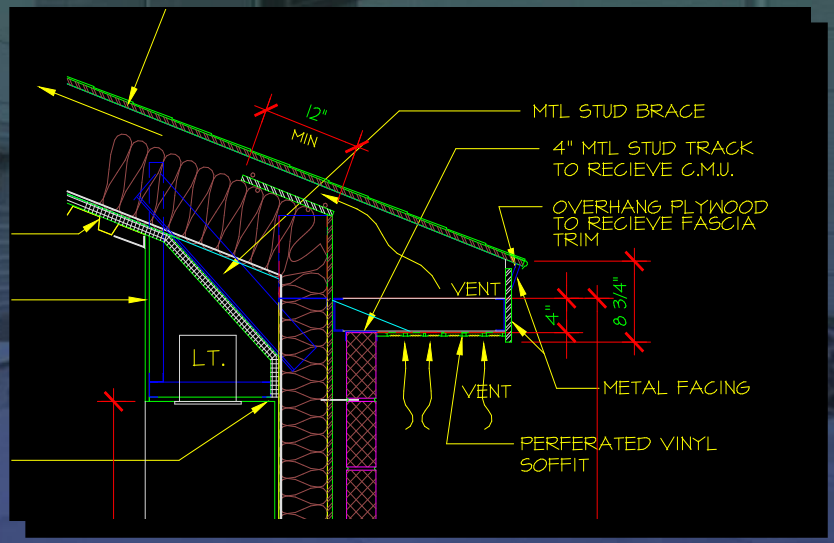
- Energy analysis tools that optimize energy performance
- Use life cycle costing
- Use a commissioning process to insure first-day performance

Sustainable

- Energy conservation and renewable energy strategies
- High-performance mechanical and lighting systems
- Environmentally responsive site planning
- Environmentally preferable materials and products
- Water-efficient design

Holistically Designed

- Designed to consider all building elements and their interaction with each other
- Long-term value and performance
- Create an enduring asset to the community
- Enhanced learning environment

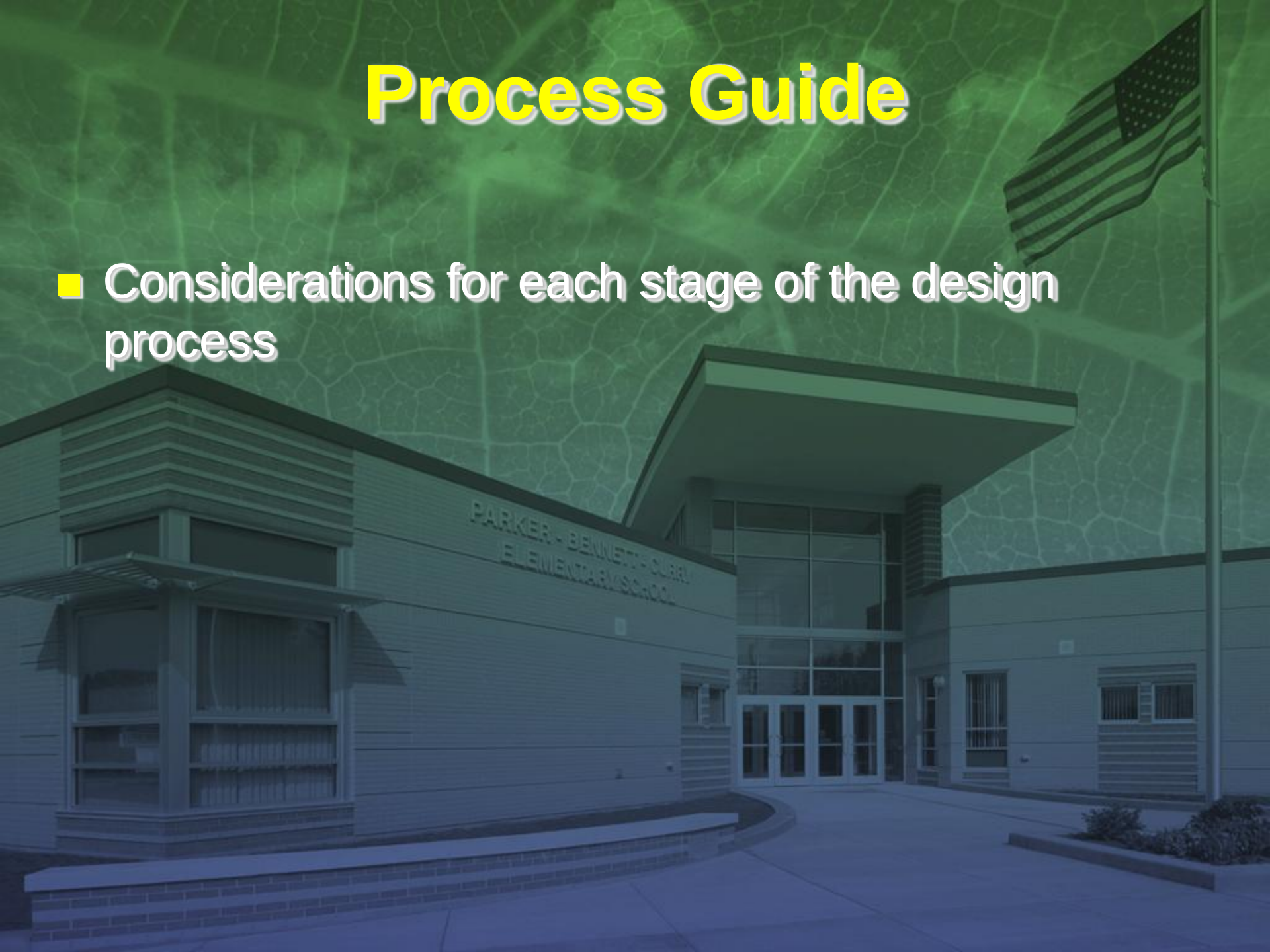


Why is a High-Performance School Valuable?

- Better student performance
- Increased average daily attendance
- Increased teacher satisfaction and retention
- Reduced operating costs
- Reduced liability exposure
- Positive influence on the environment
- Ability to use the facility as a teaching tool

Process Guide

- Considerations for each stage of the design process



SBIC High-Performance Schools Building Blocks

- Acoustics
- Commissioning
- Daylighting
- Durability
- Energy analysis tools
- Energy efficient building Shell
- Environmentally preferable materials and products
- Environmentally responsive site planning
- High-performance HVAC

SBIC High-Performance School Buildings Building Blocks

- High-performance electric lighting
- Life cycle cost analysis
- Renewable energy
- Safety and security
- Superior indoor air quality
- Thermal comfort
- Visual comfort
- Water efficiency

How Each Building Block Is Organized

- What?
- Why?
- How?

High Performance School Buildings

Building Block #9 **High Performance Electric Lighting**

What

The quality of a school's electric lighting system has an enormous impact on the productivity of students, teachers, and staff, and on the facility's operating budget. A high performance school should provide superior electric lighting by optimizing 'watts per square foot' while retaining visual quality. This can be accomplished by specifying high efficiency lamps and ballasts, optimizing the number and type of luminaires (light fixtures) for each application, incorporating controls to ensure peak system performance, and integrating complementary electric lighting and daylighting design strategies.

Why

Electric lighting can account for 30 to 50 percent of a school's electric power consumption. Even modest efficiency improvements can mean substantial bottom line savings. This is especially true in locations subject to extra 'demand charges' during times of peak energy use. Since these charges usually occur during daytime hours when schools are in full operation, any efforts to reduce the demand for power during these times will reap additional savings. An added benefit: more efficient lighting produces less waste heat, thus reducing the need for cooling and further reducing operating costs. These savings are achievable now – in any school – using readily available equipment and controls.

How

Design for High Efficiency and Visual Comfort

- Develop individual lighting designs for individual rooms or room types (e.g., classrooms, hallways, cafeteria, library, etc.).
- Consider a mix of direct and indirect light sources for each design.
- Optimize each design so that overall lighting levels (watts per square foot) are as low as possible while still providing optimal illumination for the tasks at hand.
- Avoid overlighting any space.
- Analyze the impact of the lighting system on the HVAC system, and resize as appropriate.
- Design systems to facilitate cleaning and lamp replacement.

Ross Middle School
Ross, CA

This new, 200-student facility just north of San Francisco incorporates a full range of high performance electric lighting features. Direct/indirect pendant fixtures are used to provide high quality light at low foot-candle levels. In the daylit classrooms, these fixtures also include dimming ballasts and photosensors, so they are able to vary light output depending on the levels of available daylight. Used properly, this strategy alone can save up to 60% of the electrical energy needed for lighting these rooms.

Lights have two bulbs that are separately switched, so that half the lamps can be turned off at one time, further reducing energy consumption. Some lights are also tied to occupancy sensors, so that they automatically turn off when a room is unoccupied. Finally, the entire lighting system is on a timer to ensure that all lights are shut off at night.

These features, combined with daylighting in the classrooms, create a total system that delivers high quality lighting which is also energy and cost efficient. Architect Scott Shell hopes that these features "…will not only make the school a better place for teaching and learning, but will also be used as tools that help make children more aware of how buildings and their use of energy impact the environment."

Sustainable Buildings Industry Council

How Each Building Block Is Organized

- Impacts on other systems and technologies
- Resources

How *(continued)*

Specify High Efficiency Lamps and Ballasts

- Use T-8 fluorescent lamps with electronic ballasts for most general lighting applications (classrooms, offices, multipurpose rooms, cafeterias).
- Consider using T-5 lamps if justified on a life cycle cost basis.
- Consider dimmable ballasts, especially in rooms that are daylit.

Optimize the Number and Type of Luminaires (lighting fixtures)

- Use suspended indirect or direct/indirect luminaires in classrooms to provide soft uniform illumination throughout the room.
- Consider incorporating additional accent and directional task lighting for specific uses (display areas, white boards, team areas, etc.)
- Consider the potential for using a smaller number of higher efficiency luminaires to light specific spaces, resulting in fewer fixtures to purchase, install, maintain, and clean.

Incorporate Controls to Ensure Peak System Performance

- Use occupancy sensors with manual overrides to control lighting (on-off) in classrooms, offices, rest rooms, storage areas, and other intermittently occupied spaces. Consider scheduled dimming and/or time clocks in other rooms.
- Consider incorporating lighting controls into the facility's overall energy management system, as appropriate.

Integrate Electric Lighting and Daylighting Strategies

- Treat the electric lighting system as a *supplement* to natural light; i.e., design for daylighting first and use the electric system to add light as needed during the day while providing sufficient illumination at night.
- Install controls that dim or turn lights off at times when daylight is sufficient.
- Consider photoelectric controls that are sensitive to levels of daylight.
- Consider controls that provide continuous, rather than stepped, dimming.

Impact on Other Systems and Technologies

Electric lighting systems interact strongly with a school's daylighting and HVAC systems. Daylighting strategies that are well-integrated with lighting equipment and controls will reduce the demand for electric light. If addressed by a combination of high efficiency electric lighting equipment and controls, this reduced demand can substantially lower a school's electricity usage. In addition, less electric lighting means less waste heat and, therefore, less demand for cooling. Cooling equipment can be downsized, resulting in first cost and operating cost savings to the school. *Note: Using suspended fixtures in classrooms will require ceiling heights of at least 9'6".*

Resources

- Designlights Consortium – www.designlights.org
- Energy Star Program – www.epa.gov/energystar
- Illuminating Engineering Society of North America – www.iesna.org
- Lawrence Berkeley National Laboratory – www.lbl.gov
- Lighting Research Center, Rensselaer Polytechnic Institute – www.lrc.rpi.edu
- Advanced Lighting Guidelines – www.newbuildings.org
- National Clearinghouse for Educational Facilities – www.edfacilities.org/ir/hottopics.cfm

Acoustic Comfort: What / Why

- Noise interferes with teaching and learning
  - Outside noise
  - Other classrooms
  - Mechanical systems

Acoustic Comfort: How

- Sound absorption
- Design walls to block outside noise
- Locate HVAC equipment away from classrooms
- Utilize sound enhancement system

Commissioning: What / Why

- Ensure and document that building systems operate as designed
- Test, verify, and fine-tune system performance

Commissioning: How

- Engage commissioning agent
- Develop commissioning plan
- Test and verify installation and performance of systems
- Document process and develop monitoring program

Energy Analysis Tools: What / Why

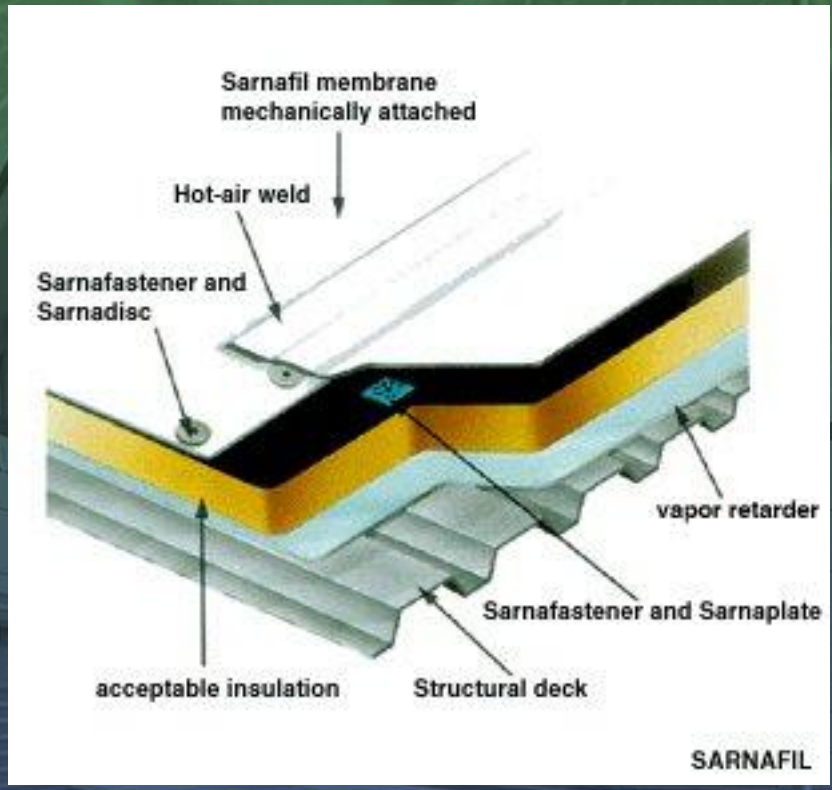
- Computer programs designed to predict a building's energy consumption
- Evaluate alternative systems performance
- Reducing energy usage is environmentally responsible and saves money

Energy Analysis Tools: How

- Architectural design tools
  - Energy 10 (www.sbicouncil.org)
  - Building Design Advisor (www.gundog.lbl.gov)
  - Energy Scheming (www.oikos.com/ebs.37.scheming.html)
- Load calculation & HVAC sizing
  - HAP, Carrier Corp. (www.carrier.com)
  - TRACE, Trane Corp. (www.trane.com)
  - DOE-2, (gundog.lbl.gov)
  - Energy Plus, (gundog.lbl.gov)

Energy Efficient Building Shell: What / Why

- Building exterior walls, windows, roof designed to be energy efficient
- An energy-efficient building shell will reduce energy use and operating cost



Energy Efficient Building Shell: How

- Holistic design
- High-performance windows and glazing
- Proper sun orientation and shading
- High levels of insulation in exterior walls and roof

Environmentally Preferable Materials: What / Why

- Building materials impact both the environment and human health
- Use non-toxic materials for healthier indoor air quality
- Use materials high in recycled content

Environmentally Preferable Materials: How

- Facilitate recycling in school operations
- Minimize construction waste
- Specify environmentally efficient, recycled, and low-VOC materials

Environmentally Responsive Site Planning: What / Why

- Select and design site to minimize environmental impact
- Design site to be outdoor learning environment

Environmentally Responsive Site Planning: How

- Conserve existing natural areas and restore damaged ones
- Minimize storm water runoff and control erosion
- Shade paved areas to reduce heat island effect
- Select exterior lights to minimize light pollution
- Develop outdoor learning areas to use site as a teaching tool

Life Cycle Cost Analysis: What / Why

A way of assessing the total cost of facility ownership over time.

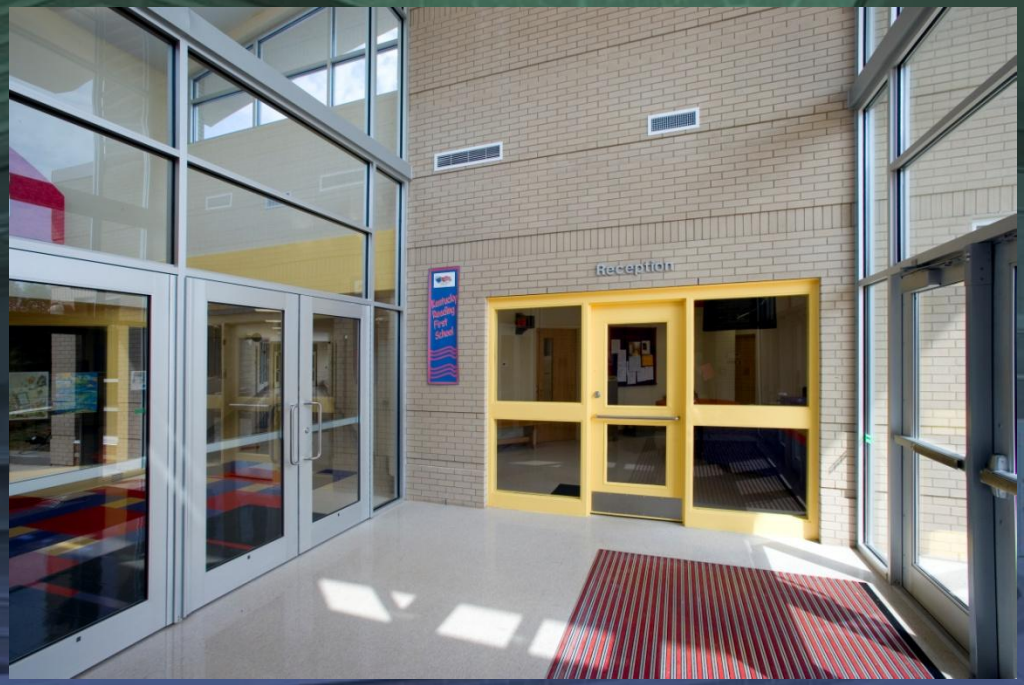
- Initial costs (design and construction)
- Operating costs (energy, water, other utilities, personnel)
- Maintenance, repair and replacement costs
- Optimize interactions over time

Life Cycle Cost Analysis: How

- A variety of LCC tools are currently available.
- One or a combination should be used to assess design alternatives at least once during:
  - Programming
  - Schematic design
  - Design development
  - Construction documents
  - Bidding and negotiation

Safety & Security: What / Why

- Building design to minimize risks of accident or injury, theft and vandalism

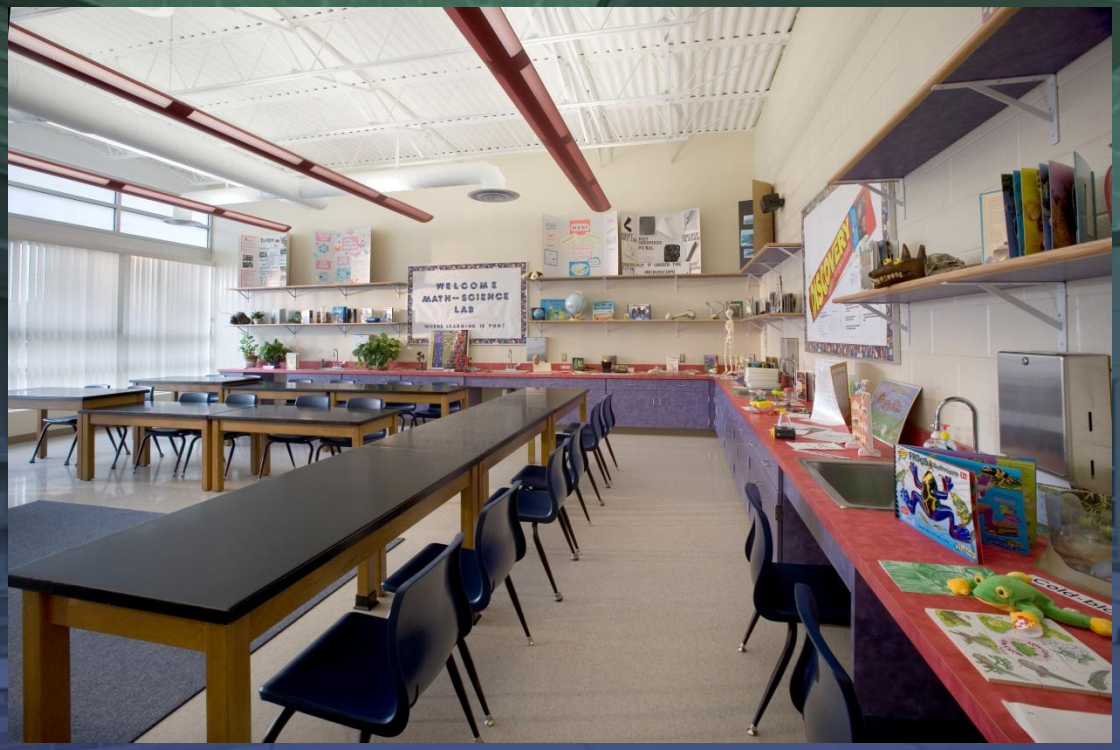


Safety & Security: How

- Increase opportunities for natural surveillance with good visibility (interior and exterior)
- Reinforce sense of territoriality, boundaries, and sense of ownership
- Control access to building and grounds
- Integrate security technology including cameras, sensors and high-security locks

Visual Comfort: What / Why

- Rich visual environment to enhance, rather than hinder, learning through proper natural and artificial lighting



Visual Comfort: How

- Integrate natural and artificial lighting
- Balance quantity and quality of light
- Control or eliminate glare

Water Efficiency: What / Why

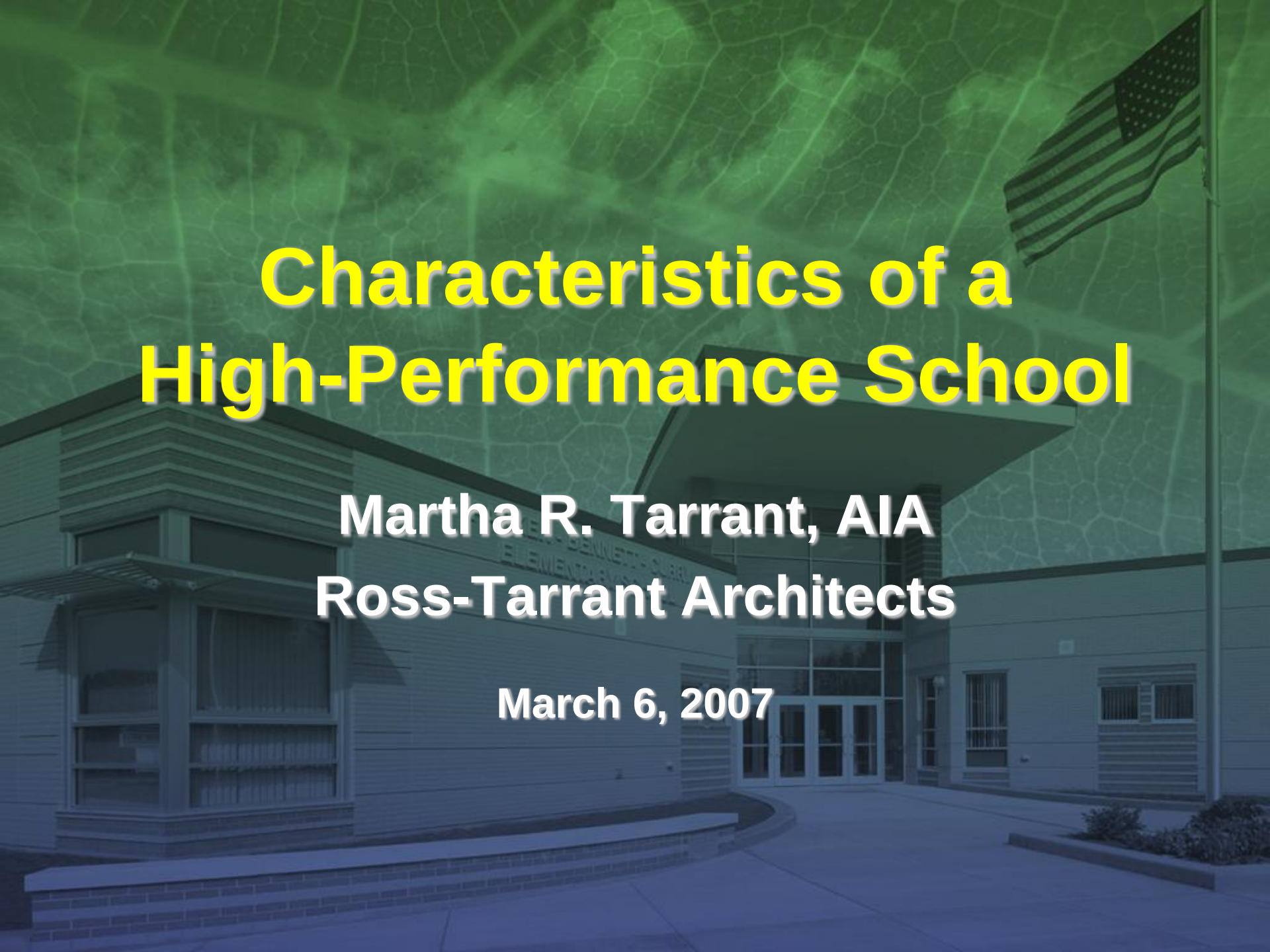
- Becoming a scarce resource
- Reduce water usage and control storm runoff
- Consider graywater reuse

Water Efficiency: How

- Specify native, water-efficient vegetation
- Minimize and use advanced irrigation
- Specify water conserving plumbing fixtures
- Specify automatic shut-off controls

Goal of a High-Performance School

- Use resources wisely to improve:
  - Energy efficiency
  - Student achievement
  - Operating costs
  - Environmental impact



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